**深 圳 大 学 实 验 报 告**

**课程名称： 现代通信原理**

**实验项目名称： 实验六**

**学院： 电子与信息工程学院**

**专业： 电子信息工程**

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**实验时间： 2023.04.06-2023.04.13**

**实验报告提交时间： 2023年4月13日**

**教务部制**

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| **实验目的与要求：**  微信截图_20230508165322 |
| **内容和步骤：**   1. **Plot the roll-off system with alpha=0,0.5,1 respectively in both time and frequency domain under the condition of Nyquist rate being 10kBaud and sampling rate of 1e5Hz** 2. **The roll-off system with alpha=0,0.5,1 in time domain**   At first we use the rcosdesign() function to plot the roll-off system. Here we should determine some parameters including span alpha and sps. When it comes to sps, it refers to sample per symbol that is obtain by Fs/Rs which has been given in the problem. Span refers to filter span in symbols. In the experiment, we set span=6, sps=10 and alpha=[0,0.5,1]. Then we plot the three roll-off systems. The codes are shown in the following figure.  微信截图_20230508200050  微信截图_20230508200101  The result is shown in the following figure (left). However, we observe that the highest point of three roll-off systems are not coincident which is controversial to the theoretical result as shown in the following figure.  微信截图_20230508195826 微信截图_20230508195838  微信截图_20230508202114  So additionally, I plot the three roll-off systems by the formulation as shown in the above figure (red marked). We use “xt” array to reserve each calculative result in convenience to plot. The codes are shown in the following figure. And the plotted result has been shown in the above figure (right). The result is more closed to theoretical result. We observe that the lager alpha, the less trailing the roll-off system.  微信截图_20230508200134  微信截图_20230508200215  微信截图_20230508200228   1. **The roll-off system with alpha=0,0.5,1 i**n frequency domain   Similarly, we calculate the value in the frequency domain according to the formulation and use “Xf” to record the calculative result. Then plot it. The codes are shown in the following figure.  微信截图_20230508200308  The three roll-off systems in frequency domain are shown in the following figure. We observe that all the roll-off systems can be equivalent by ideal low pass filter. The band width is 1Hz and all the roll-off systems coincident at f=0.5Hz. What’s more, the larger alpha, the more dramatic the roll-off system.  微信截图_20230508195850   1. **In a roll-off system with alpha=0.5, assume that the sampling rate is 1e5Hz** 2. **Generate a binary sequence with length of 100**   The codes are shown in the following figure. It is worth to say that we should perform the level change for the binary sequence. That is convert 0 to “-1” (convert it into bipolar waveform). In the experiment, we set symbol duration time Ts=1s and sample 100 times for each symbol. Then we plot the original signal waveform.  微信截图_20230508213208  微信截图_20230508213218   1. **Upsample the sequence to make symbols (zero-padding)**   In fact, the upsample rate determine the Rb (symbol band width of). Here we set Rb=1e4. The codes are shown in the following figure.  微信截图_20230508213308   1. **Let the Nyquist rate be 5kBaud and 20kBaud**   微信截图_20230508213322   1. **Generate the corresponding roll-off systems**   In the experiment, we set span=6 and alpha=0.5. Since the different Nyquist rate of the transmission system (roll-off system), the receiver might will receive signal that has inter symbol interface or not. In the following, we will analyse it. The codes are shown in the following figure.  微信截图_20230508213330   1. **Signal and systems convolution**   We should input the ‘same’ parameter to convince that the length of convolution result is the same as input signal. The codes ares shown in the following figure.  微信截图_20230508213340   1. **Plot both the original signal and the received signal**   Here we should promise that the N of upsample and downsample is identical. Since the input signal is bipolar waveform, Vd=0. After decision, we plot the received signal waveform. The codes are shown in the following figure.  微信截图_20230508213353  微信截图_20230508213404  The following figure shows the original signal, received signal with Rs(Nyquist rate)=5kB and received signal with Rs(Nyquist rate)=20kB. Then we observe that the shape of received signal with Rs(Nyquist rate)=5kB has changed compared to original signal. And the shape of received signal with Rs(Nyquist rate)=20kB is identical with the original signal. The means it happen ISI for the roll-off system with Rs(Nyquist rate)=5kB and no ISI for the roll-off system with Rs(Nyquist rate)=20kB. The reason is that Rs(Nyquist rate)=20kB is larger than and twice times as Rb(2W)=1e4Hz. It satisfies the no ISI condition. However, Rs(Nyquist rate)=5kB is less than Rb(2W)=1e4Hz (fb(Rb)>2W). It doesn’t satisfy the no ISI condition.  微信截图_20230508213826  In order to deeply verify our conclusion, we change the Rb(2W)=0.5e4 and perform the experiment again. The result is shown in the following figure. We observe that no matter roll-off system with Rs(Nyquist rate)=5kB or with 20kB, there is no ISI for the two received signal waveform. The reason is that Rs(Nyquist rate)=5kB is equal to Rb (fb=2W) and Rs(Nyquist rate)=20kB is larger and four times as Rb (fb>2W). All satisfies the no ISI condition.  微信截图_20230508213850  In order to objectively justice the result. I conduct 10 independent experiments and record its bit error rate (BER). The following left figure shows the BER for the two roll-off system under the condition of Rb=1e4. We find that roll-off system with Rs(Nyquist rate)=20e3 has no BER during 10 experiments but the average of BER for roll-off system with Rs(Nyquist rate)=5e3 is 0.128 during 10 experiments. The following right figure shows the BER for the two roll-off system under the condition of Rb=0.5e4. We observe that roll-off system with Rs(Nyquist rate)=20e3 and 5e3 has no BER during 10 experiments.  微信截图_20230508213917 微信截图_20230508213904  Additionally, in order to vividly observe that process of sampling. I plot the the original impulse sequence and sampling curve in the same figure.  The following left figure (when Rb=1e4) shows that the roll-off system with Nyquist rate=5kB will sample the binary sequence wrongly during some sampling moments as marked by red rectangle. And the roll-off system with Nyquist rate=20kB samples all the binary sequence successfully during all the sampling moments.  The following right figure (when Rb=1e4) shows that the roll-off system with Nyquist rate=5kB and 20kB samples all the binary sequence successfully during all the sampling moments.  微信截图_20230510202205 微信截图_20230510202953 |
| **实验结论：**   1. The roll-off alpha is a measure of the rate at which the magnitude of the signal decreases beyond its bandwidth. A higher roll-off alpha indicates a steeper roll-off and a narrower transition band, while a lower roll-off alpha indicates a more gradual roll-off and a wider transition band. The lager alpha, the less trailing the roll-off system. 2. If the received signal has no ISI, it must satisfy the following condition.   微信截图_20230508224531 |
| **指导教师批阅意见：**    **成绩评定：**  **指导教师签字：**  **年 月 日** |
| **备注：** |

注：1、报告内的项目或内容设置，可根据实际情况加以调整和补充。

2、教师批改学生实验报告时间应在学生提交实验报告时间后10日内。